

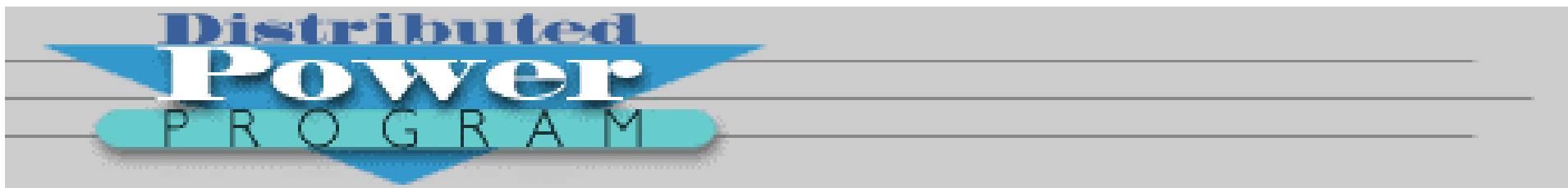


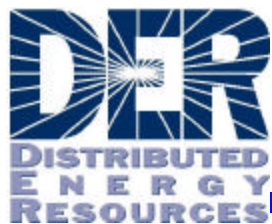
Distributed Power Program Overview: Interconnection & System Integration R&D

Joe Galdo

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Office of Power Technologies
U.S. Department of Energy**

**Distributed Power Program/Industrial DG Program Annual Review Meeting
Arlington, VA
January 29, 2002**

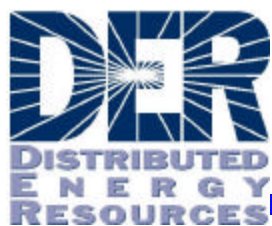




Mission



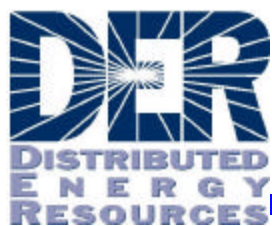
The Distributed Power Program conducts RD&D on interconnection and system integration technologies and on regulatory policies to remove Technical, Institutional and Regulatory barriers impeding realization of the full potential of distributed energy resources.



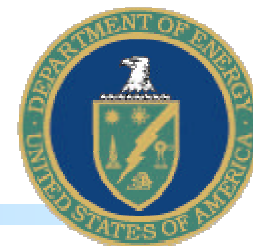
Vision



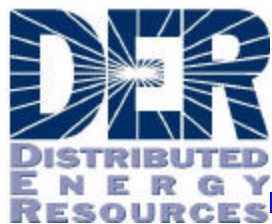
By 2020 a modernized electric distribution system, standardized interconnection requirements, affordable and reliable modular plug-and-play interfaces and intelligent adaptive control technology, along with a regulatory and institutional environment that recognizes the benefits of DER, will enable DER to become a significant contributor to a reliable and secure electric supply, a clean environment and a highly productive economy.



NEP Goals



- Modernize conservation
- Modernize our energy infrastructure
- Increase energy supplies
- Accelerate protection and improvement of the environment
- Increase energy security

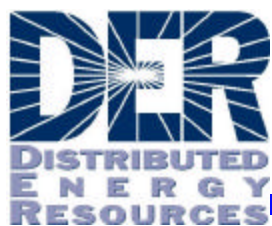


Goal



Contribute to achieving the DER market penetration goal of 20% of new capacity by 2020 through:

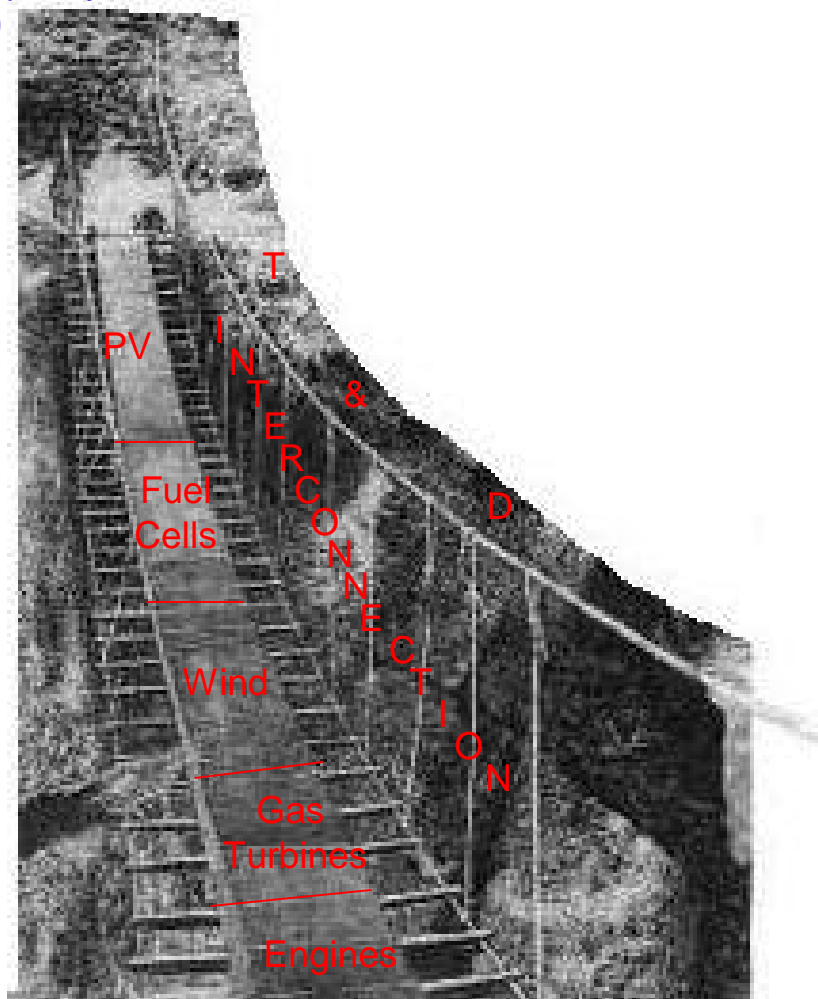
- Reducing interconnection & system integration costs
- Reducing the hassle factor
- Achieving full benefits and value for DER



Bridge to the Future



20% of Annual Capacity
Additions by 2020





Program Strategy



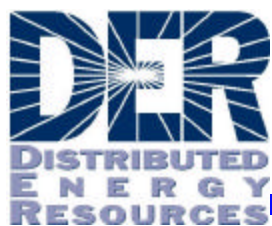
- Technical Standards
 - Interconnection with electric power system
 - Electrical/Fire/Mechanical Safety
 - Data/Communications
 - Software
 - Architecture/Modularization/Physical connection
- System Integration R&D
 - Increase component integration
 - Develop cost-effective advanced plug-and-play interconnection and control technologies
 - Enhance capability to integrate, interact, and provide operational benefits
 - Enterprise energy management systems and resource planning
 - Grid support, ancillary services, and load/demand management
 - Adaptive, intelligent technology
- Mitigation of Regulatory and Institutional Barriers
 - Utility interconnection and related tariffs
 - Emissions regulations
 - Local siting and permitting



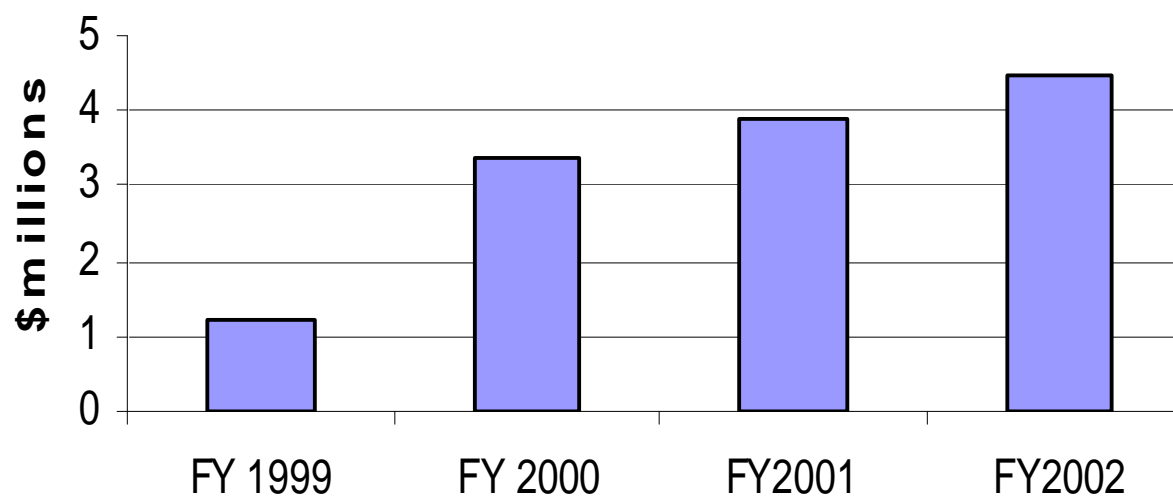
Metrics

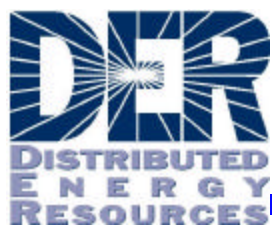


- National interconnection standard in 2002 & major revision by 2007
- UL/ANSI standard and certification process to cover interconnection equipment for all DG by 2003
- Model DG interconnection rule by 2003
- Model emissions rule for small DG by 2003
- 15% reduction in the cost of interconnection hardware by 2005 and 30% by 2010.
- 10-year MTBF for inverter-based technology by 2005
- Modular universal plug-and-play interconnection technology by 2010



Budget





Program Achievements



- December 1998 Workshop
- DP Program Initiated in January 1999
- Initiation of IEEE P1547 DER Interconnection Standard Project in March 1999
- First Program Review in December 1999
- Publication of *Making Connections* in May 2000
- Workshop on RTO/ISO issues FY 2000
- System Integration R&D Solicitation Awards in FY 2000/2001
- Interconnection Technologies Workshop July 2001
- Ballot on draft IEEE interconnection standard March 2001 and recirculation in September 2001



Program Achievements



- NREL DER interconnection/system integration test facility operational November 2001
- Pilot field test of interconnection requirements conducted at Nevada Test Site in November 2001
- DTE and GE modeling of grid impacts
- 4 workshops for state utility regulators in FY 2000/ 2001
- Reports on regulatory issues September 2001
- 6 workshops for local code officials in FY 2001/2002
- Draft model emissions rule for public comment November 2001



Technical Standards



- IEEE P1547 Standard for Distributed Resources Interconnected with Electric Power Systems
- Communications and Other Standards
- Revised UL 1741 to Include all DG Interconnection Technologies
- Development of Certification Process
- Modeling DG Interactions and Impacts on Grid
- Laboratory and Field Testing
 - National Renewable Energy Laboratory
 - Nevada Test Site
 - Distributed Utility Integration Test

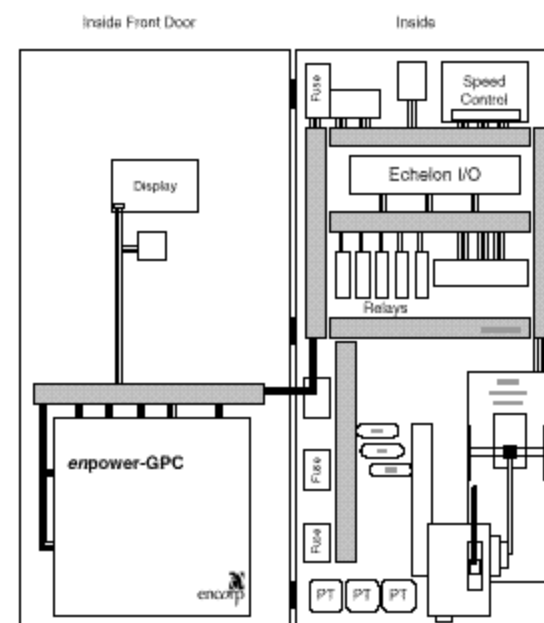


System Integration R&D



- Universal plug-and-play interconnection system
 - Inverter-based plug-and-play across multiple technologies (2 kW – 500 kW)
 - Fully integrated utility-grade switchgear, metering, and system-level command and control for synchronous machines (<3 MW)
- Aggregation, grid support, ancillary services
- Enterprise energy management technology
- Automated adaptive intelligent interconnection and control
- Modeling
- Laboratory and Field Testing

- Improved and Expanded Protective Relay Performance
- Increased EMI and Surge Withstand Immunity
- Revenue Grade Metering
- Expanded Suite of Communication Options To Enable Flexible Inter-Device & Network Connectivity
- Accept Multiple Power Sensors
- Data Logging and Sequence of Events Logging
- Alarming, Trending, and Wave Form Capture





Software-Enabled Functions



Examples

- Application customization
- Synchronizer (frequency, phase, and voltage matching)
- Import/export control (with fully-automated peak shaving)
- Isochronous kW load sharing control
- “Soft” loading and unloading control
- Base load control
- VAR/Power Factor control
- Digital power metering, monitoring
- Over/under-voltage for generator breaker and utility tie breaker
- Over/under-frequency for generator breaker and utility tie breaker
- Phase sequence voltage
- Voltage-restrained overcurrent
- Automatic transfer switch control
- Sync check
- Auto-synchronizer
- Directional power
- Directional reactive power
- Reverse-phase/phase-balance current



Advanced Plug-and-Play Interconnection



Local Interfaces		Microprocessor Based Power Conditioning, Control, Communications		External Interfaces	
PV	Power	DER	Power Conversion/ Conditioning	Grid (Power)	Utility
Wind					Microgrid
Gas Turbine	C3				
Gas Engine					
Microturbine			Protection		
Fuel Cell					
Storage					
AC Loads	Power	Load	DER and Load Control	Control (C3)	Remote
DC Loads	C3				Enterprise Management
Temperature	Power	Sensors	Ancillary Services		Aggregator
Motion					Utility
Detection	C3		Revenue Grade Metering		Electricity Markets
Alarms					
	Power	Control	Communications	Data (C3)	Weather
PC Workstation	C3				

Energy Management

- Web based network energy information
- Supports real-time data collection
- Forecasts load and generation
- Energy system optimization
- Aggregate commodity purchasing
- Sale of services to the grid

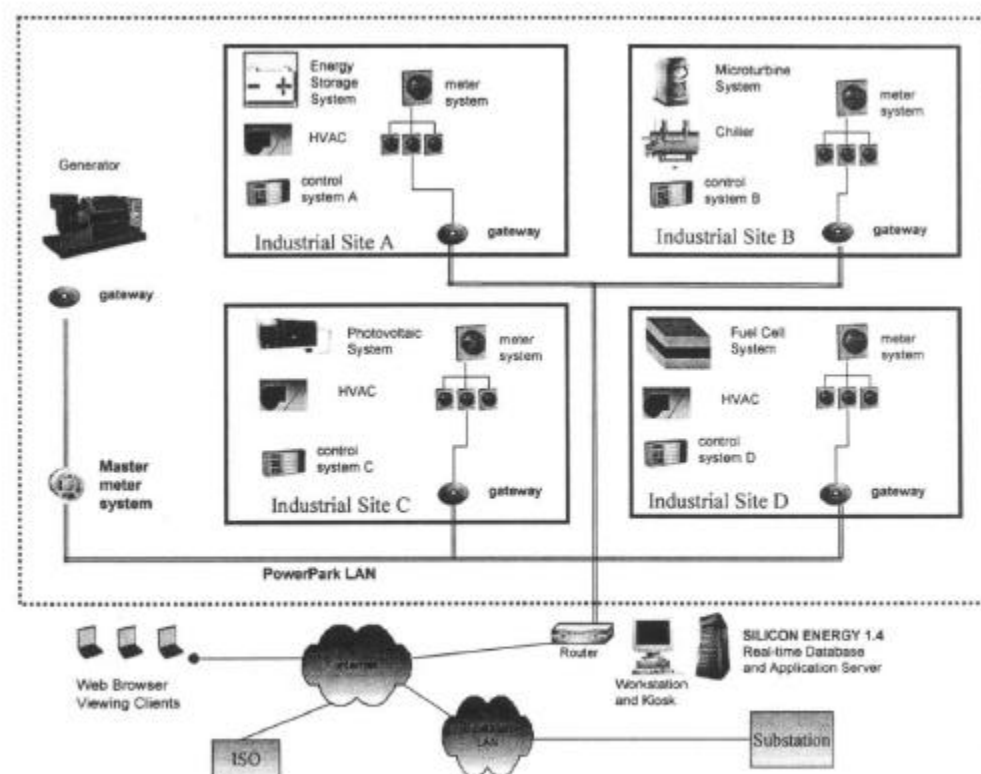


Figure 1 Enterprise Energy Management and Dispatch Control Software



Regulatory & Institutional Barriers



- **Utility Regulation**
 - Working with NARUC and States developing interconnection rules
 - Tariffs: back-up charges, exit fees, uplift fees, incentive rates, etc
- **Local Codes and Standards**
 - PTI/Urban Consortium Action Plan
 - DER Road Show
 - Training video
 - Handbook for local inspectors
- **Environmental Regulation**
 - Environmental Barriers Case Studies
 - Model Rule for Small DG
 - RAP, State regulators, EPA, DG industry

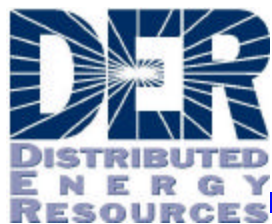


Partners

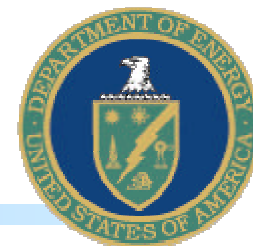


American Gas Association
Caterpillar
Competitive Utility Strategies
Detroit Edison Co.
Distributed Utility Associates
DTE Energy Technologies
Electric Power Research Institute
Electrotek
Emersom Electric/ Asco Power Technologies
Encorp
Endecon Engineering
Energy Signature Associates, Inc.
Exelon Corp
Gas Research Institute
General Electric Corporate R&D
Kelso Starrs and Associates
Kinectrics Incorporated
Long island Power Authority

National Rural Electric Cooperative Association
NiSource Energy Technologies, Inc
Onsite/Syscom
Orion Engineering Corp.
Pacific Gas and Electric Co
RealEnergy
RLB Communications
Spire Solar Chicago
Silicon Energy
The Regulatory Assistance Project
Underwriters Laboratories Inc.
California Energy Commission
New York State Energy R&D Authority
Urban Consortium
Colorado School of Mines
University of Massachusetts Lowell
University of Wisconsin- Madison



DOE Interaction



- Participation:
 - National Labs: NREL (lead lab), INEEL, ORNL
 - Golden Field Office
 - Nevada Operations Office/Nevada Test Site
- Coordination:
 - National Labs: PNNL, SNL, LBNL
 - Regional Offices
 - PV, Wind, CHP, Fuel Cell, Microturbine Programs
 - CERTS



Planned FY 2002 Milestones



- Approved interconnection standard
- Draft revised UL 1741
- Draft model interconnection rule
- Prototype enhanced interconnection system
- Environmental barriers report
- Additional workshops for utility regulators
- Additional workshops for local code officials
- Test plan
- Updated 5-year plan
- System Integration R&D Solicitations



DPP Website



www.eren.doe.gov/distributedpower/